Signal Characteristics, Spectral Emissions, and Interference Analyses

Outputs

- Technical publications and presentations demonstrating research results.
- Comparative measurements and analyses of DP-UWB, DS-UWB, and MB-OFDM signals.
- Measurement and analysis of DTV susceptibility to ultrawideband signals.

Since the Federal Communications Commission (FCC) permitted low power ultrawideband (UWB) emissions between 3.1 and 10.6 GHz in February 2003, a number of companies have developed new UWB technologies for application in wireless personal area networking (WPAN) to achieve high data rates at short distances (nominally less than 10 meters). Examples of these developments include Multi-band Orthogonal Frequency-Division Multiplexing (MB-OFDM) and Direct-Sequence Ultrawideband (DS-UWB) technologies. MB-OFDM achieves its ultra-wide bandwidth with a 528-MHz wide OFDM signal that hops between 14 different bands. In contrast, DS-UWB combines conventional spread spectrum techniques and pulse shaping to achieve its ultra-wide bandwidth.

Questions arose regarding how UWB signals interfere with legacy systems such as C-band satellite television, which demodulates signals that lie within the frequency band allocated for UWB operations. On March 22, 2004, ITS entered into a Cooperative Research and Development Agreement with Motorola/Freescale Incorporated to address these questions. We hypothesized that UWB interference potential could be quantified in terms of UWB signal characteristics. To test this hypothesis, a test system was designed and built to inject UWB signals with known characteristics into a C-band satellite digital television (DTV) receiver and quantitatively measure interference susceptibility via signal quality metrics, e.g., segment error rate, pre-Viterbi bit error rate, and modulation error ratio, taken from various points in the receiver signal processing chain. Figure 1 shows the test set-up. Results from the experiment are being published in a three-part NTIA Report Series entitled “Interference Potential of Ultrawideband Signals.” Part 1, released in February 2005, describes the test setup and procedures in detail.

Figure 1. Test set-up (photograph by F.H. Sanders).

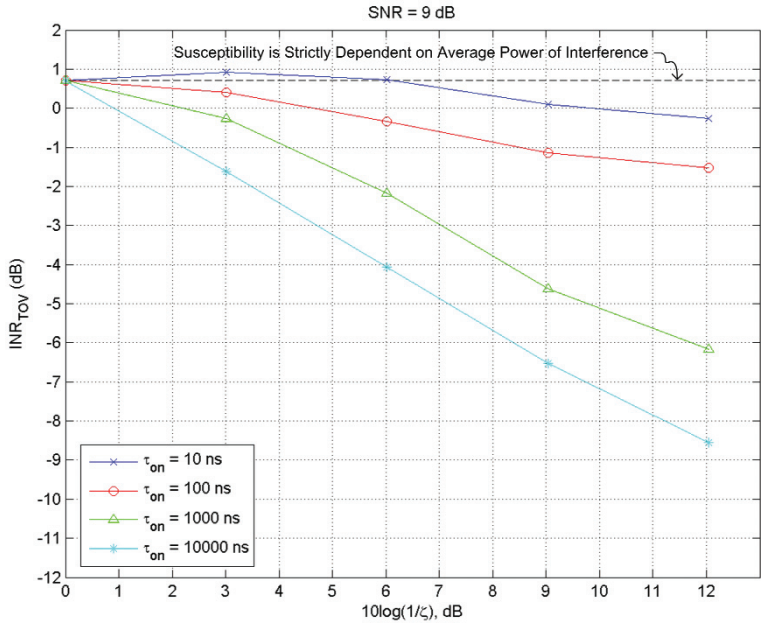

Figure 2. INR_{TOV} *versus 10log(1/ζ) for a DTV receiver operating at* SNR = *9 dB and exposed to gated noise interference.*

Part 2, released in August 2005, provides test results for gated-noise interference to DTV receivers. While continuous- and gated-noise signals are unlikely to be used in communications, their similarities to DS-UWB and MB-OFDM, respectively, are unmistakable and their analytic tractability is profoundly useful. This report demonstrates that DTV susceptibility to gated-noise interference cannot be predicted by interference power characteristics alone. As illustrated in Figure 2, it was found that DTV susceptibility, quantified by the average interference power that caused DTV degradation at the threshold of visibility (INR_{TOV}), is also dependent on temporal characteristics (e.g., τ_{on} and ζ) of the interfering signal and the bandwidth of the DTV receiver. Moreover, high correlation was observed between susceptibility and forward error correction performance of the receiver.

Part 3, *to be released*, will provide results from tests that measured DTV susceptibility to actual UWB signals. In this experiment, a DTV victim receiver was exposed to Dither-Pulse UWB, DS-UWB, and MB-OFDM interference. It was found that categorization of the UWB signals into three regions of common DTV susceptibility could be achieved with a priori knowledge of the temporal structure of the signal and bandwidth of the victim receiver.

Recent Publications

M. Cotton, R. Achatz, J. Wepman, and B. Bedford, "Interference potential of ultrawideband signals, Part 1: Procedures to characterize ultra-wideband emissions and measure interference susceptibility of C-band satellite digital television receivers," NTIA Report TR-05-419, Feb. 2005.

M. Cotton, R. Achatz, J. Wepman, and P. Runkle, "Interference potential of ultrawideband signals, Part 2: Measurement of gated-noise interference to C-band satellite digital television receivers," NTIA Report TR-05-429, Aug. 2005.

M. Cotton, R. Achatz, J. Wepman, and R. Dalke, "Interference potential of ultrawideband signals, Part 3: Measurement of ultrawideband interference to C-band satellite digital television receivers," NTIA Report in progress.

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